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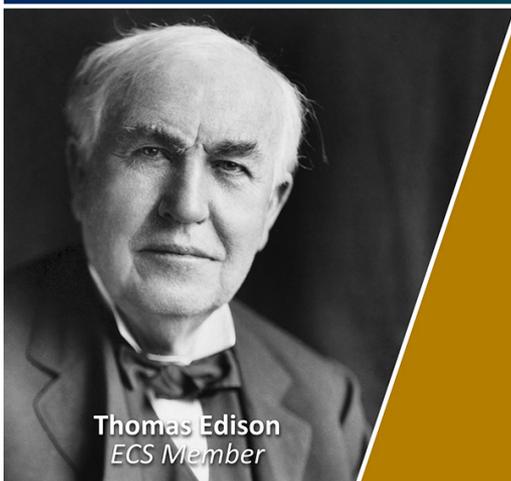
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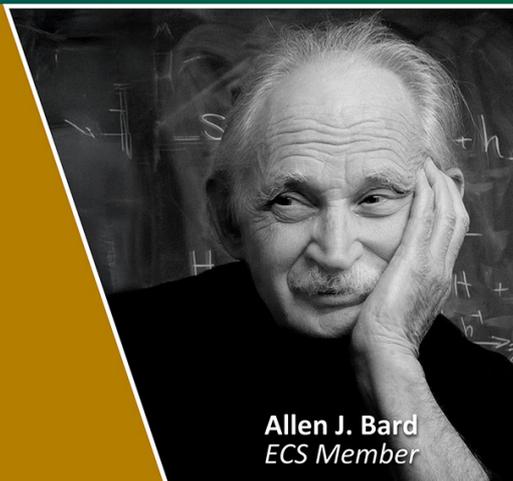
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# Flood risk management in New Zealand: A case study of the Northland urban community

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**Abstract.** The Northland river is characterised by having a short stream and large catchments. Heavy rains in the region trigger the rapid rise of the water levels and causes flooding, affecting the urban community in the flood plain with flash floods and river overflow as double threats. The government-initiated programs to protect urban communities such as 'predict and mitigate' but primarily focuses on physical infrastructure protection. While providing infrastructure is beneficial, developing a resilient community comprises more holistic strategies. There is a need for improving the local capacity to enhance resilience. A resilient, human-focused mitigation strategy which includes the affected communities, as well as the existing infrastructure, can reduce flood risks more efficiently. This paper explores the ways the Northland communities follow to mitigate existing flood risks, including their perceptions of the current flood protection strategies. This study investigates also the social and cultural elements that influence responses to flood risks. The main recommendation, of the study advocates a community-based risk management plan to complement the government's strategy to efficiently mitigate flood risk in the urban Northland.

Keywords: Community-based risk management, flooding, and urban community

## 1. Introduction

Over the last few decades, the notion of flood risk management (FRM) has become increasingly popular worldwide [1]. In the case of urban flooding, a thorough understanding of the influence of urban expansion on flood risk is a necessary component of good flood risk management. [2]. There is a belief that integrating non-structural approaches is more beneficial than adopting infrastructure-focused approaches for flood management decision-making and practises [3]. The steering committee in New Zealand argues that the country requires the most nuanced possible flood risk management framework to minimise the distress and disruption caused by floods [4]. The steering committee highlighted the need for collaboration between central and local governments and the community in managing essential elements that contribute to flood hazards.

Flooding in Northland erodes public trust in the government's ability to manage water resources, lead responsible urban growth, and prepare for and respond to recurring and unpredictable emergencies [5-8]. Flood management issues are typically caused by inadequate involvement in the FRM process with citizens, the private and non-private sectors, and civic volunteers [9]. Thus far, most flood protection efforts in the Northland have focused on physical infrastructures, such as flood protection infrastructure, erosion management, and channel maintenance [10-12]. Individuals and communities are required to



undertake primary responsibility for their health, safety, and livelihoods due to floodplain urbanisation [13-15]. Both government and communities played the current leadership role in the FRM for its short-term and long-term plans [5, 16]. The local community is the finest resource for discovering insights gained from previous experiences and recommending future practices [13, 17-19].

This study uses a qualitative research method including an open-ended questionnaire, key informant interviews, and ethnographic interpretation. The study explores ways on how the central and local Governments can best manage elements contributing to flooding risk in collaboration with the affected communities. The study also documents the legislative, social, and cultural elements that influence the communities' risk response to flooding in the Northland. Furthermore, because climate change and uncontrolled development are expected to increase urban flooding in the future, general improvements to FRM could be made, such as developing long-term integrated strategies using planning tools and practices to address growing risk [20]. We encourage governments to bring diverse viewpoints and build flood governance initiatives beyond engineering-based flood protection plans.

## 2. Literature review

A major cause of urban flooding is by poorly managed urbanisation [21], increasing areas of impermeable surfaces [22], poor flood management strategies [23], lack of flood early warning systems [24], and disposal of solid waste in drainage lines [25]. Whilst urban flood issues are prevalent in almost every megacity globally, it also happens in small towns built on floodplain like in many cases within New Zealand. Ignoring policy and regulations, people worldwide continue to encroach on flood-prone areas, narrowing the channel and reducing its carrying capacity [26]. The New Zealand Steering Group for Flood Risk Management (2008) recommends respecting environmental limits and integrating FRM with sustainable land management to protect urban areas [4]. As a result, we must comprehend flooding in urban areas, the evolution of flood risk management (FRM), and flood policy and regulation.

### 2.1. Flooding in the urban environment

Approximately two-thirds of New Zealand's population lives in flood-prone areas [27]. A flood is a runoff into a river or stream that exceeds the channel's capacity and inundates typically dry terrain next to the channel [28]. Flooding is a natural process, but it becomes a hazard when it impacts human lives or property. Floods may very well be predicted by monitoring rainfall and water flow patterns, and New Zealand can forecast all of this year's floods within a few hours [29]. In contrast, a flash flood is hard to predict and might occur unexpectedly, which can be caused by a storm or a dam leakage. Any flood can have economic, social, and cultural consequences for populations living in floodplain regions next to rivers and streams [30], as well as environmental consequences such as soil and channel erosion and instream habitat alteration [25, 31]. Since floods first affected livelihoods, people have attempted to manage floods to protect lives and property [3, 32].

In the popular study about urban theory, Short [33] writes that the insensitivity of urban planners to environmental challenges, also known as 'wounded cities,' has resulted in urban areas being prone to disaster, thus fostering public distrust. The probability of flooding has grown due to the rapid increase in impermeable surfaces and urban expansion [22]. Likewise, when rain falls over an extended period, the intensity of urban floods increases. The likelihood of urban flooding is predicted to rise more as the climate changes [34]. Like many other regions of the country, many townships in the Northland are built near rivers and the sea, making them vulnerable to both urban and coastal floods and flash floods exacerbated by the Northland's hilly terrain.

### 2.2. Global flood risk management compared to New Zealand

Approaches to flood risk management established in Asia, New Zealand, the United Kingdom, and the United States are all heading in the same direction. Previously, they implemented a large-scale structural strategy to flood control, with all movement focused on flood protection structures. In today's practice, global flood management is increasingly shifting away from traditional technical standard-based methods and towards a risk management strategy that prioritises governance, policy, and community

concerns. However, the implementation varies according to each country's characteristics, capacity, and challenges.

Each flood management approach recommends a particular set of treatments since flooding issues are always specific [3]. With the adoption of FRM in New Zealand, a longer-term, catchment-wide strategy is now feasible [35]. The decision-making process is based on an alternative trade between minimising life-cycle risks, promoting opportunities, and allocating resources [1]. Consequently, integrating the structural and nonstructural measures becomes the centre stage in FRM research [36]. New Zealand introduced a catchment-based strategy in 1941 for flood protection control at the local level [37]. A portfolio of integrated multisector solutions can represent the benefits of a catchment-based approach. In New Zealand, it is comprised of structural and nonstructural measures, as well as risk management tools.

### *2.3. Community-based flood mitigation*

'How to invest in community engagement?' is a critical subject to consider while implementing community-based solutions [38]. To answer these questions, one must examine the government's current initiatives. The Northland Regional Council, for example, established the Communications and Engagement Strategy in 2018 to accomplish the council's long-term strategy's goals and priority areas [5]. The regional council formed the catchment flood working group in response to the national government's pronouncement that "people should be consulted in decision-making regarding acceptable risk levels and mitigation efforts for local groups." [5, 39, 40].

Local community groups have established a deep understanding of local environmental hazards based on their history and close contact with the land and resources [19]. Knowing where the hazards are and how to effectively manage land are the first steps towards comprehensive urban flood management [34, 41, 42]. Furthermore, the local community believes that people may be protected from flood hazards by keeping the water safe and protecting the land [43, 44]. Combining research and local knowledge provides valuable guidance for managing land use and protecting the catchment, allowing us to mitigate such threats.

Storm, flood, and landslide information and wisdom are prominently documented in Māori (indigenous people of Aotearoa New Zealand) oral stories and traditions [19, 45]. The details of these events assist in explaining the causes of disasters and warning people about the nature of local environments [17, 46]. Oral histories, songs, naming locations, and tales about natural hazards are part of the culture and offer a wealth of knowledge that contributes to understanding local natural hazards and future hazard management and mitigation [19, 47].

Furthermore, it is critical to recognise that incorporating local culture and expertise into FRM entails more than just documenting and reporting. That is, the process should include members of the local community, their culture, and their knowledge. By allowing the community to take responsibility for hazard planning, response, and recovery, the knowledge they hold will become more than simply traditional wisdom and will play an essential role in all decision-making processes [48, 49].

## **3. Research methods**

Three case study regions were chosen (Whangarei, Kaipara, and Far North districts). Key informant interviews, an open-ended questionnaire, and document analysis supported the research study. A qualitative approach was adopted, considering the need for an in-depth discussion with participants. The case study approach is a recognised qualitative design seeking meaning and understanding, using the researcher as the primary data collector and analyst [50].

According to Williams (2007), qualitative data approaches allow for discovery within the study process [51]. The importance of local factors in affecting flood occurrences and flood control measures prompted a more in-depth examination. As a result, interacting with community members allowed for a more in-depth discussion of these aspects, which are difficult to quantify statistically.

### 3.1. Study area and demography

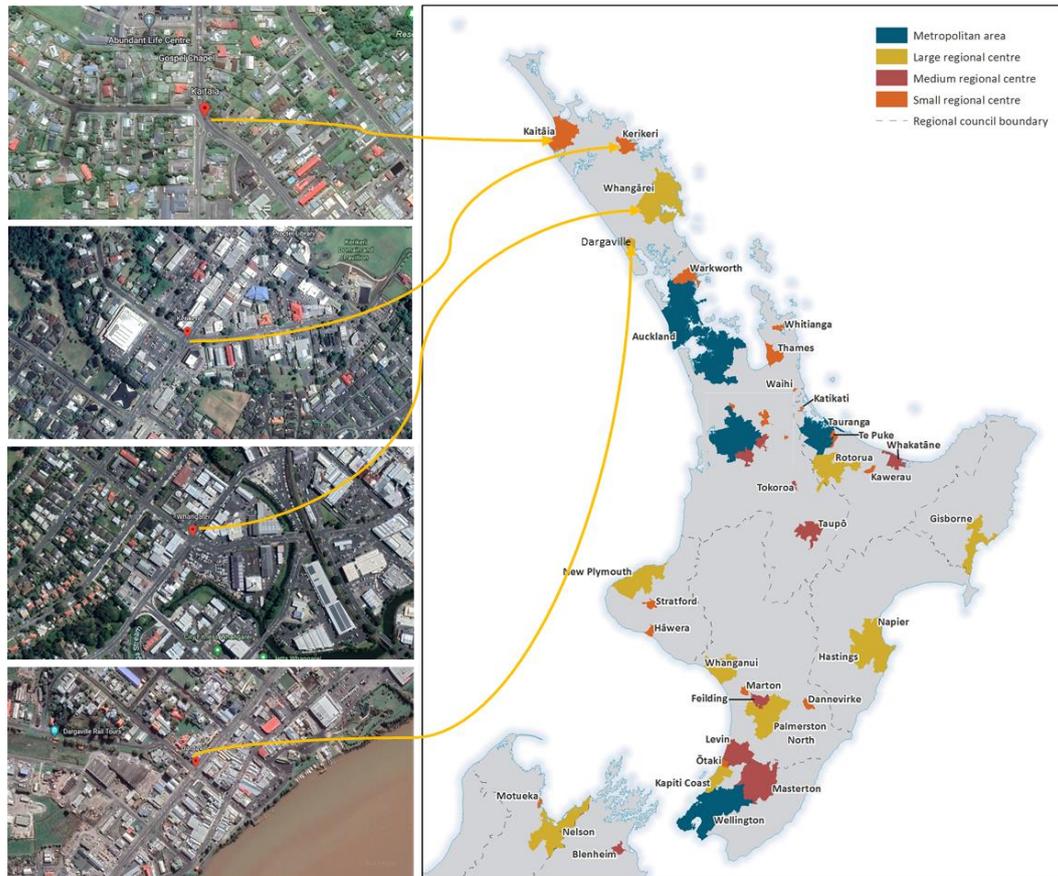
Northland is one of New Zealand's sixteen local government areas, located on the northern side of the nation, surrounded by the Pacific Ocean and the Tasman Sea. The shoreline and river floodplain are home to most of the Northland population. Northland is the country's most rural region, yet its population is evenly distributed between urban and rural areas (Table 1). In the Northland, around half of the population resides in urban areas, a stark contrast to the rest of New Zealand, where urban areas account for 86 per cent of the population and rural regions for only 14 per cent. The regions were chosen because the town represents a small developing urban area, with most of its people coming from the surrounding rural areas. Many towns around the country share Northland's regional centre's characteristics (Figure 1), and it differs significantly from urban areas in metropolitan areas such as Auckland, Wellington, Christchurch, and Dunedin.

**Table 1.** Northland population by place of residence

Parameter	Region	As of June 2011,	
		Number	% Region total
Total Population	Northland	158,200	100%
	New Zealand	4,405,200	100%
	Position among 14 regions <sup>1</sup>	8th	n.a.
<b>Place of residence</b>			
Urban	Northland	80,120	51%
	New Zealand	3,795,460	86%
	Position among 14 regions <sup>1</sup>	10th	14th
Rural	Northland	78,080	49%
	New Zealand	609,740	14%
	Position among 14 regions <sup>1</sup>	3rd	1st

<sup>1</sup> The 14 regions are Northland, Auckland, Waikato, Bay of Plenty, Gisborne, Hawkes Bay, Taranaki, Manawatu-Wanganui, Wellington, Tasman/Nelson/Marlborough, West Coast, Canterbury, Otago, and Southland. Source: Statistics New Zealand, Population Estimates and Projections, Census for 2001 and 2006 in Northland Regional Council information page: Society. (Statistic New Zealand 2018)[52]

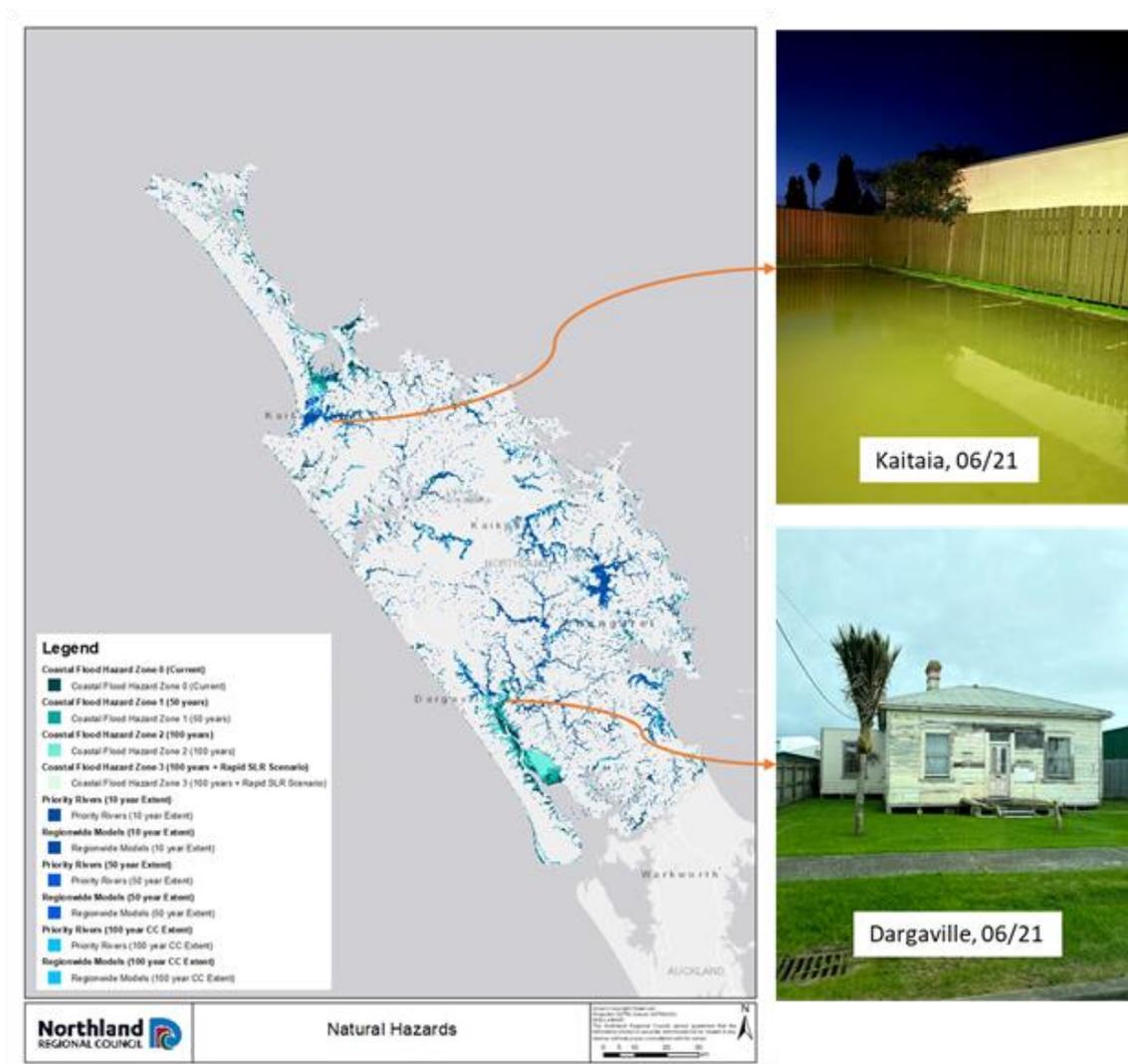
Northland is one of the regions that have the lowest Gross Domestic Product (GDP) per capita of all New Zealand regions in 2020 [53]. In contrast to the GDP, the region's urbanisation increases fast [54]. Following WWII, the community (mainly in the Northland) relocated from the countryside to the city, searching for paid jobs. During the 50 years from 1936, the world recorded the fastest urbanisation rates in history, as the migration of 83 per cent of New Zealand's indigenous population from rural to urban areas happened in the Northland [55, 56]. While Northland is New Zealand's least urbanised region, it has 194,600 people living in cities [57]. As a result of urbanisation in flood plain zones, Northland is also one of New Zealand's most cyclone-prone and flood-prone locations [12].



**Figure 1.** New Zealand urban area map and study area (source: Statistics NZ)

### 3.2. The area after flood events

Even though Northland has seen several local floods ranging from minor to significant occurrences over the centuries, the national popularity of flooding is lower than in any other significant region in the country. Flooding in Northland is challenging to anticipate due to various factors such as debris, ground conditions, river channel, and fallen trees. From historical events, the 2007 floods were the worst in over 150 years, destroying 3,000 hectares of farmland in the Far North, 5,000 hectares of garlands in Hikurangi, and causing significant damage to crops, livestock, houses, communication infrastructures, highways, and business assets [58, 59]. Still, in 2007, after the towns had recovered from the March flooding, another massive flood struck in July, causing further devastation. Further, due to the flood in 2020, half of the population in the region was cut off from the major road network due to landslides, infrastructural damage, and submerged access [60]. The flood events have mainly affected the houses (Figure 2) and disrupted infrastructure to the point that the region's State Highway 1 (SH1) access has been closed for about a year for repairs from 2020 to 2021 [61, 62].



**Figure 2.** After flood illustration in flood zone for Kaitaia and Dargaville (Source: Author)

### 3.3. Data Collection

The data was collected through a field tour and attendance at three Northland flood working group meetings. The open-ended questionnaire, key informant interviews (Table 2), and ethnographic interpretation were qualitative methods. The open-ended questionnaire obtained 110 qualified responses. The meeting was attended by representatives from local administration organisations and centralised agencies responsible for natural hazard emergencies and impacted company owners and households. The council and the flood group committee (Table 2) convened the meeting to review the flood mitigation strategy implemented in respective catchment regions. Every meeting session was written down, summarised, and utilised as a reference for the next scheduled meeting.

**Table 2.** Key Informants

Categories	Identifier
Government Agencies:	G.1
Northland Regional Council, Whangarei district Council, Far North District Council, and Kaipara District Council	G.2 G.3 G.4
Experts:	E.1
Flood related engineers	E.2 E.3
Community representatives:	C.1
Business, Cultural, and Farming sectors	C.2 C.3
Flood meeting observation:	F.1
Kawakawa, Kaihu and Dargaville, and Kaeo Catchments	F.2 F.3

Source: Authors

*3.3.1. Document analysis.* The literature review enhances and consolidates the knowledge base and helps integrate the finding in the study [63]. Planning papers were a significant foundation of the study since a significant emphasis of the research was researching how local governments responded to and managed the consequences of flood hazards. Documents used for this study included Northland Regional Council Long-Term Plan 2018-2028, Whangarei District Plan, Kaipara District Plan, Far North District Plan, Ministry for the Environment guidelines for local Government in New Zealand, and Northland Infrastructure strategy: Flood protection and control. Documents were chosen based on their relevance to the topic. Local government documents can be used to investigate how the local geographical setting influences policy and decision-making in these areas [64]. The literature review helps to set the base knowledge to form the survey and interview questionnaire.

*3.3.2. Site observation.* A field trip to the Northland region was conducted in May-June of 2021 to allow face-to-face interviews with key informants, with the interview following a semi-open-ended structure. The other purpose is to see and experience the area, river system, drainage system, and flood protection infrastructure that operate in the area. The trip consisted of interviews in three districts and site visits, which were accomplished via a private vehicle. The site observation focused on the areas with a history of the flood and areas marked in the Northland's flood hazard map as flood-prone.

*3.3.3. Interview and survey.* Interviews were conducted with individuals identified as key informants, with the interview following a semi-open-ended structure for the case study based on Yin (2003) to make the point that critical informants can offer their insights [65]. The approach also proposes different and new avenues of research that can be pursued, making them a valuable addition to any research [66].

### 3.4. Analysis

The study was analysed under three themes: Structural measures, non-structural and legislative measures, and emergency management measures.

## 4. Findings and discussion

River management and flood control measures must be repurposed, modified, or refurbished to address current difficulties, such as adaptation to climate change-induced flood occurrences [37]. In addition, the plans must meet a broader range of community, environmental, cultural, and economic goals than in the past [4]. As the concept of modern FRM began to emerge globally in the early twentieth century, studies about flood management focused on the engineering approach and the social and cultural approach [1]. As the population grew and flood plains developed, increases in flood losses, and the impact of climate change, a new approach was needed. Risk decision-making and management need to be applied in practice and not only in theory.

Flood management in New Zealand has a regional approach to flood risk management, with nothing in the national planning strategy. The approach might result in regional discrepancies or, conversely, allow various areas to pursue effective local solutions [67]. In the Northland, there has been a significant effort to change the flood management system and shift towards more community-based systems. Utilising the flood group meeting in the priority catchments, the government encourages the community to participate in the decision-making process and evaluate the current urban policy and planning in terms of FRM.

New Zealand encompasses the four Rs; reduction, readiness, response, and recovery to achieve comprehensive flood risk management [68]. The practices will not eliminate the flood risk, but it treats significant component to reduce the risks. The study found the key lesson learned highlighting the urban community's best practices in the flood risk management field based on the data collections. The critical lesson is grouped into structural measures, non-structural measures, including a community-based approach and legislation, and emergency management.

### 4.1. Structural measures

Most river management, drainage, and flood control projects date back to the 1950s. The value of the assets covered by these schemes has steadily risen to the point that it is now highly substantial. The scale of surrounding urban development has also increased. The sort of land use activities on this protected territory is more intensive than that originally anticipated during plan design and construction. A new view on the critical role that schemes play is now necessary.

The central government's long-term plan generally emphasises the structural management and floodproofing asset. However, less attention was given to the nonstructural aspects of flood management, in this case, community resiliency measures. Efforts within flood risk management must create a solution based on community characteristics and cultural values. One of the focal points in flood risk management is preparing and increasing community awareness and the capacity of local government authorities to handle local flood situations. After many significant floods, the government launched several flood protection projects; however, it mainly focused on constructing a dam, a floodway, stopbanks, and a floodwall.

The Awanui flood scheme, the Keo-Whangaroa flood scheme, and the Hopua te Nihotetea detention dam near Whangarei are the three primary flood management measures in Northland [11]. The cumulative asset value of these three schemes is \$22.7 million [69]. The council's flood infrastructure is minimal compared to other regions; however, this infrastructure strategy includes additional flood systems in response to demand.

The data found that the need for flood protection and control works in Northland, unlike many other forms of infrastructure, is not directly connected to population expansion. Instead, demand is influenced by the following factors: a geographic expanse of population centres and assets located inside floodplain zones; public perceptions of flood danger and tolerable levels of flood risk and public perceptions of flood risk; and population density in flood zone that has an impact on service level expectations.

In the Northland, structural measures including stop banks, dams, dikes, and groynes are necessary and effective in preventing ordinary floods, which are relatively frequent. However, they have a limited performance against the extreme events that also occasionally happen. In many circumstances, providing adequate flood protection to settlements in Northland is neither physically viable nor financially feasible. An integrated strategy is required in this setting, such as working with communities to identify and map flood-prone regions, build community response plans, issue flood warnings, and carry out local river work to decrease flood risks.

#### *4.2. Non-structural and legislation measures*

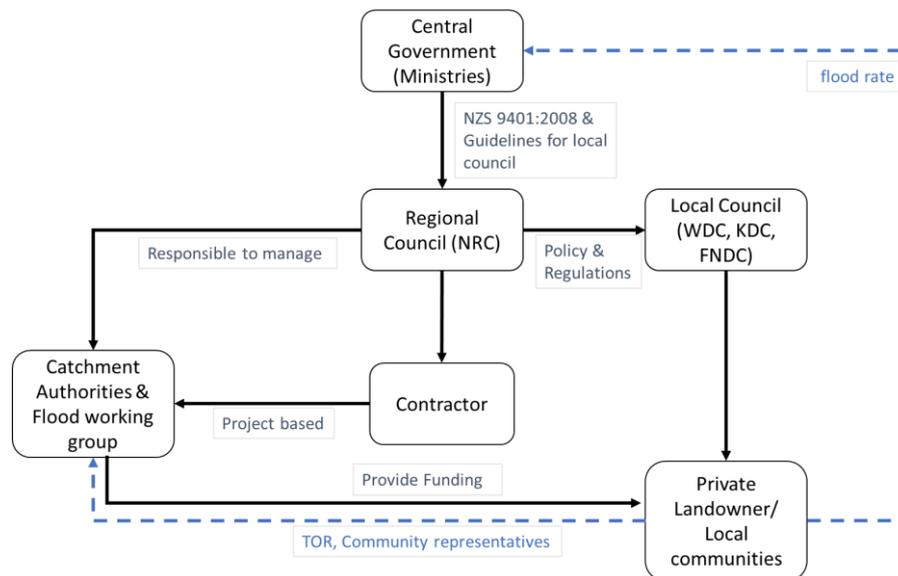
When the flood happens, and the structural protection fails, local communities were forced to use their knowledge and resources to survive flood crisis chaos and save lives and assets. Fortunately, communities had known the possibility of a flood happening in the areas throughout the flood zones, flood experienced, and engaged in flood preparedness. Therefore, knowledge of community-based flood risk management (CBFRM) and understanding of policy and regulation is beneficial for the FRM strategy in the future.

*4.2.1. Catchment-based flood working group.* Northland has the direction to utilise community-based flood risk management by having a flood working group under the national catchment authorities. The flood working group could be the platform to enhance the non-structural flood management approach. Aside from discussing the infrastructure for flood protection with the community, a risk-based approach and educational strategies can be introduced. Further, collaborating with the community to design the policy and regulations help to keep people away from flooding by controlling the land use and activities in areas subject to flooding. Also, involving the community in emergency management planning and emergency responses enable the communities to respond and recover from flooding effectively and efficiently.

The current national program for flood inundation and risk assessment provides an investigation of flood exposure according to the type of land use and risk to buildings, infrastructure networks, and long-term sustainability of flood schemes or defences [70]. The flood working group can complement the program by providing a forum for researchers, iwi, stakeholders, and the government to discuss flood inundation hazards and risks and co-develop strategies for a more flood-resilient Aotearoa New Zealand. Each catchment group should work with case study communities to understand how they react to flood hazards and increasing climate change impact and to help them develop adaptation strategies.

*4.2.2. Regulatory framework in national and local level.* Many legislations in New Zealand exist to accommodate flood risk management. These legislations – Local government Act 2002, soil conservation and rivers control act 1941, and rivers board act 1908 – relate to hazard control measures such as providing stopbanks, channel maintenance and clearance, dams, and the land drainage act 1908 for the drainage schemes. Several agencies also provide flooding information and education, including scientific and practical information about flooding and ways to minimise the impact of flood events (LIM & Local government official information and meetings act 1987). Civil Defence and Emergency Management Act 2002 provides the legislative framework for flood hazard preparedness, responses, and recovery measures [71]. Moreover, the government also provides disaster relief funding to assist local communities with the large-scale flood; however, flood loss insurance and financial assistance were usually provided by the Earthquake Commission [72].

Based on the literature overviewing New Zealand legislations in flood management, this study summarises the legislative relation of the flood management and protection action work in the Northland Region (Figure 3). Six main entities were linked based on their power and responsibilities to achieve this multi-level relationship chart.



**Figure 3.** Legislative relation from central to local in FRM. (Source: Author)

The central government gave the national direction to the local government in the sustainable management of natural and physical resources. Following this direction, FRM works managed under the Local Government Act 2002 and Soil Conservation and river control act 1941. However, the ministry can intervene in all local decision making to fund and facilitate flood mitigation works undertaken by the local council except for River Board Act 1908 (RBA) and the Land Drainage Act 1908 (LDA) [16]. Since 1987, the central government has discontinued funding for flood control schemes, and there is no new regulation.

Following the standard NZS 9401:2008 and some other directions from the central government, the regional council is responsible for facilitating the consistent administration of the flood management act. The regional council also must ensure that the local policy is implemented. In flood works, the regional council is responsible for managing the flood working group under the national catchment authorities. In flood working groups, the council facilitates local communities' representatives and private landowners to discuss flood management. Further, the regional council is also responsible for managing stakeholders as contractors in carrying the flood work project.

The local government is then responsible for addressing soil conservation and flood management at the local level to give flood emergency disaster relief. They are also responsible for providing funding for a private owner, initiating flood and river management, stormwater, and drainage infrastructure. The local government also needs to ensure flood and drainage works' environmental and safety issues. Further, the local government supports private owners doing the flood work and the private landowner responsible for paying rates.

The central government managed the rates and distributed them to the catchment authorities and flood groups. The working group provides the funding for private landowners to carry the flood works in neighborhoods. The flood working group committee is the representative chosen by the community group using the Term of Reference (TOR) created by the regional council, which have content specific depending on the diverse character of the community in the catchments.

**Table 3.** The flood risk management standard NZS 9401:2008

NZS 9401:2008	Current implementation in Northland
Catchment-based management to provide a natural framework within which to manage the flood risk	There are 28 priority catchments identified that provide flood protection under the flood working group. However, there are areas not included in the priority catchment that also prone to flood.
Sustainable management brings natural and social systems together over the long term to provide a context for flood risk management decisions.	The local government adopts the latest good practice and acknowledges and actively manages residual risk. Local councils in the Northland are provided with the resources, tools, and information about future climate change impacts. The study summarised by NIWA, conducted in 2018 'Climate change impact in the northland'. The study can be the baseline for decision-making in flood management.
Adaptive management ensures that changes in natural processes, hazards, exposed values, and vulnerability are identified by monitoring and addressed on time.	The adaptive management combining structural with the nonstructural approach has already been initiated. However, the operation is at a slow pace. Adaptive management focuses more on the structural based solution. Even though the regional council facilitate the flood work meeting with the community representatives, the program and solution for Flood management still focus on infrastructure, river channel, flood gate, and river cleaning. More programs are demanded by the communities, such as educational seminars, workshops in flood mapping, understanding the early warning system or evacuation strategy.
Risk management to encourage a broader assessment of strategies and options, anticipation of change, and awareness of residual risks.	NIWA leads initiatives to quantify the risk of natural flood hazards and climate change impact. The risk management strategies are also embedded in the river and flood mitigation works, floodplain and catchment management, and infrastructure strategy.
Comprehensive risk treatment strategies include reduction, readiness, response, and recovery.	Following the New Zealand concept, Northland also implement the 4 Rs in the natural hazard management practices. However, the implementation of its strategy varies between the three districts of Northland (Kaipara, Far North, and Whangarei districts)

The literature concludes that New Zealand FRM is more regional with less involvement in national-level planning policy related to flood management. This situation may lead to inconsistency between regional councils. However, this approach equally allows different regions to implement the effective local solution to manage the flood. Moreover, the flood risk management standard NZS 9401:2008 and The Northland River Management Policy recommends a decision-making process and is not technical, prescriptive, or performance-based.

#### 4.3. Emergency management technique

A partnership is needed to facilitate emergency operations. Coordination between governmental agencies, military forces, and other stakeholders in an emergency is essential. The National Emergency Management Agency (NEMA) provides important policy direction and advice to regional and territorial authorities on flood emergency preparedness, response, and recovery. NEMA becomes involved in

emergency response. When more than one region is involved, international coordination is required, or national or central government resources (such as the NZ Defence Force) are required. The Ministry of Social Development can also assist people affected by floods. For example, residents affected by the floods can be provided with emergency payments for food, clothing, and bedding needs; reimbursements for items not covered by insurance including food or damaged property; payment for hotel, motel accommodation for people evacuated; financial assistance for people who have been evacuated and lost their livelihood; and Taskforce Green assistance to help with clean-up operations.

A Civil Defence and Emergency Management Group (CDEMG) with representatives from all local, territorial authorities in the region and the Regional Council oversees regional emergency management. The CDEMG collaborates with the police, fire department, lifeline organisations, and other emergency response associations. Rainfall, river flows, and lake levels are all monitored by regional agencies, and flood protection is maintained. Staff from the council also calculate the expected rises in river and lake levels downstream and provide communities with warning information. Both regional and territorial authorities are required to monitor the state of the environment. Every five years, Councils must make available to the public the results of its monitoring of the effectiveness of its plans. Resource consents must also be monitored. This monitoring ensures those plan policies and rules remain effective in addressing issues such as flood management.

## 5. Conclusions

Northland's lesson has pointed out that flood risk management implemented by communities and local government is crucial for urban flood protection. Communities and local governments can design solutions that are adaptable to the needs of their local communities and are consistent with the local culture, policies, and priorities. From the people's view, the flood risk management mechanism does not have to focus on the prediction and action approach, generally used for physical protection measures. Some catchments in rural Northland's experience showed that the success of flood risk management lay in community involvement which urban communities can learn and apply. Effective flood risk management requires close coordination among all areas, including floodplain and non-floodplain communities. Policymakers and urban development experts, both tangible and intangible aspects, should be well advised to listen to the communities and empower them to be the front part of the solution.

Further, the Northland region cannot be separated from the fact that rural areas have the most significant portion despite its population moving to the urban side. As rural and urban have different characteristics, different methods and measures should be taken to conduct the research. A study focused on rural flood risk management, and resiliency could contribute tremendous additional knowledge and contribution to the overall project.

## 6. Acknowledgement

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